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Towards Extracting Motivation from Mobile Learners' Movement Trajectories

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Abstract. This work in progress paper proposes a novel approach for evaluating the level of motivation of hikers who are guided by a location-based mobile learning application (LBML) through an outdoor recreation area. The aim is to extract this information, which is needed for evaluating the motivating effect of the digital tool, by tracking the hikers' movements, and analyzing the resulting trajectories for spatio-temporal patterns related to motivation. In this preliminary work, we present the general approach for identifying these patterns and provide details with regard to the study design.

Keywords. Movement analysis, Motivation feedback, Location-based mobile learning

1. Introduction

The term 'location-based mobile learning' (LBML) describes a concept in formal education where the presented content is explicitly related to the learner's location, and the learning experience is mediated by technology such as mobile phones or tablets (Vavoula & Sharples 2009). A major advantage of LBML lies in the learner-centered approach, which leads to a situated and highly interactive learning process, as well as the socio-constructivist process, which can have a positive effect on the learning objectives and the learner's intrinsic motivation (Sharples et al. 2005).

1.1. Location-based Mobile Learning for Tourism

LBML are not merely used in a school-related context, but also in tourism. Thus, an increasing number of visitors to recreation areas or cities carry mobile phones and use digital tools provided by the authorities or other stakeholders to augment their tourist experience (Buhalis & Law 2008). Hikers, for instance, typically use digital tools to receive information about their surrounding environment (e.g., vegetation, wildlife) at specific locations.

Naturally, the developers or providers of such systems are highly interested in maximizing the users' satisfaction. The traditional way of gaining insights into the user experience or motivation when using such tools are paper questionnaires, which, however, have several disadvantages, such as a high workload for the participants and the analysts, or imprecise or incomplete results due to participants becoming tired or failing to remember parts of an experience.

1.2. Learner Motivation

Motivation affects learning and behavior. Several learning motivation theories exist in the literature, and are often based on psychological needs. With the concept of the ARCS motivational process, Keller (1999), for instance, introduced a motivation theory for computer-based instruction. In this work, four dimensions of motivation are suggested, including *attention* (A), *relevance* (R), *confidence* (C), and *satisfaction* (S). Thus, learners pay *attention* if the content is new, attractive and adventurous. The *relevance* is perceived as high if the content is of high public interest or high usefulness in the future. If a task is perceived as too difficult, *confidence* is low. If it allows the learner to apply the acquired skill or has an exciting outcome, however, the *satisfaction* is high.

Consequently, relevant questions with regards to LBML services may include whether the digital content is relevant and delivered at the right location, and therefore serves the goal to increase the tourist's attention; whether it is understandable, trustworthy and delivers a useful outcome; and whether it is perceived as exciting and satisfying to the user.

1.3. Analysis of Human Movement Trajectories

Trajectories represent the movement of a moving object in geographical space, and are modeled by a sequence of time-stamped geospatial coordinates (Lee & Krumm 2011). There are various methods available for trajectory analysis with their main areas of application in domains such as way-finding research, mobility analysis, animal tracking or tourism research (Sailer et al. 2016). Related examples include the work by Spaccapietra et al. (2008), who present the concept of semantic trajectories, where the raw movement data is annotated with rich meaning such as the trip purpose,

used traffic mode or the location of points of interest (POI), or Spangenberg (2014), who describes how trajectories can be augmented with semantic information obtained from questionnaires, and analyzed for deriving the behavioral patterns of tourists.

1.4. Study Aims and Research questions

Due to the fact that most modern smart phones allow position tracking, in this study, we propose to extract user motivation by analyzing these movement data. Our aim is to identify patterns which can serve as indicators for the users' motivational states while moving and interacting with the LBML service, thus providing evidence from real, measured data rather than the self-reported statements collected in user questionnaires. Currently, there is no educational theory that suggests a potential connection of motivation to one or more characteristics of learner movements.

Accordingly, this study aims to develop a framework that allows for detecting motivation in the movement data of mobile learners and tourists. We focus on the scenario of hikers who are guided by a LBML application through a nature reserve, and address the following research questions:

- Is it possible to identify learner motivation from movement trajectory patterns?
- Can we evaluate the motivating effect of certain parts of tours guided by LBML services with location-based content in outdoor areas?

Related subordinate research questions include:

- Can highly motivated hikers be detected based on them performing additional activities due to their higher motivational level?
- Can like-minded hikers be identified based on their spatio-temporal relations (e.g., users moving together or towards each other)?
- Can new exciting/motivational locations in conservation areas be discovered through the analysis of human mobility patterns?
- Which environmental variables (weather, slope, view, etc.) influence the motivation of the participants positively (or negatively)?

2. Study Design

In order to develop our framework, a field study will be conducted with visitors hiking in a recreation area close to Zurich. An existing LBML platform will be used for providing location-based content to the hikers while simultaneously tracking their movements.

2.1. Sites, Participants, Hardware and Software

The participants for the study are tourists visiting the chosen area and hiking within the study area. Each participant can use his/her own smartphone to complete an excursion, which is predefined using the LBML tool. The intended route for the nature trail follows a crest and is used by hikers and tourists. The path is approximately 1 km long and will include four to six learning units located along the trail. The learning content of the excursion will be related to regional characteristics and of an appropriate level for adolescent as well as adult participants.

The used LBML platform allows editors to create digital trails with individual geographical stations or areas conveniently by using a web browser. Learners can then access those stations guided by their mobile phone positioning and consume the localized learning content while being situated in and interacting with the intended environment. The system records movement trajectories as well as other, semantic information (when and where a particular button was clicked, location requests, etc.).

After a brief introduction to the LBML platform, participants will receive a pseudonym to enable anonymous data collection during the study and ensure their personal privacy.

In order to allow independent validation of the accuracy of the trajectory data collection, a second tracking device is used that records GPS as well as acceleration data at high temporal resolution.

2.2. Procedure

In order to collect ground truth information about the participants' motivation, we will use the Instructional Material Motivational Survey (IMMS) that is based on the ARCS model (introduced in Section 1.2). It allows the systematic evaluation of motivation in various educational settings, and consists of a questionnaire with 36 Likert scale statements where each refers to one of the four basic components of the ARCS theory (Keller 2010). The questionnaire will be filled in after completing the trail. The instrument was validated by Huang et al. (2006) and improved to adapt it to the evaluation needs of computer-based tutorials. The questionnaire will be integrated in the LBML platform.

After the data from the IMMS questionnaire have been collected, the trajectories will be preprocessed and related to the corresponding participant's results. Subsequently, the movement data will be examined for patterns that show some degree of commonality among participants with comparable motivational levels, and may therefore serve as indicators for learner motivation. To assess the baseline motivation of hikers on the described path, a control group of participants will not have access to the LBML tool,

but will only be tracked and asked to answer the IMMS questionnaire.

Based on existing theories on motivation, we will test the trajectory data especially for relations with regard to the following movement patterns: turn-around, extended-walk, extended-stop and interrupted-walk.

In the following, these movement patterns are elaborated on a concrete example. A particular learning location could feature the task to spot natural features that originated from the last glacial period (e.g. moraine), compare it with a map from the last glacial maximum, and take notes.

Turn-around pattern: Occurs when a learner voluntarily takes the effort to return to a previously visited location because there was an information board about the geology within this area which could help to solve the task.

Extended-walk pattern: Occurs when a learner walks a longer distance to the optimal site for exploring and observing the area in case of the location of the learning station having an obstructed view.

Extended-stop pattern: The stated time per learning unit is extended by the learner to interact extensively with the provided information. The learner reads all the information about the described time period and then returns to the LBML application interface to review and solve the task.

Interrupted-walk pattern: Several stops can be detected during the learner's walk between two planned stops due to the fact that certain features can be observed from different better suited locations for solving the task. (Of course, there are several possible reasons for stopping along the trail. After completing the trail, participants will indicate if they stopped due to content-related or other reasons.)

3. Expected Findings & Discussion

We expect to identify a set of spatio-temporal movement patterns that correlate to high levels of motivation. On this basis, we aim to provide a method to evaluate learner motivation based purely on their trajectories as well as to formulate general recommendations regarding the design of motivating LBML trips in natural settings. These findings could support the development of similar applications in school or touristic contexts. Due to the explorative character of this study, however, care must be taken when transferring its results to other settings with different learning materials. Nevertheless, this possibility could be evaluated in a follow-up study.

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